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# A new species and a new record of *Pyxine* (*Physciaceae*) with norstictic acid from São Paulo State, Brazil

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Abstract — In the course of a study of *Pyxine* species in São Paulo State, Brazil, *Pyxine jolyana* was recognized as a new species. It has norstictic acid in the medulla, a rare feature in South American species. Also, another species with norstictic acid, *P. fallax*, is recorded for the first time from the Neotropics. A world key to the *Pyxine* species that produce norstictic acid is presented.

Key words — *Pyxine albovirens, P. patellaris, P. retirugella* var. *capitata, P. retirugella*, lichenized fungi

## Introduction

The genus *Pyxine* differs from other foliose genera in *Physciaceae* by the epithecium becoming purple with a solution of potassium hydroxide. It shares a dark pigmented hypothecium and ascospores of the *Dirinaria*-type with *Dirinaria*, but differs from that genus by the presence of rhizines.

Other important features of the genus are the occurrence of apothecia with carbonized margins in most species, with a more or less developed and pigmented internal stipe, the presence of lichexanthone in the upper cortex in about half of the species and also the frequent pigmentation of the medulla, generally in the upper layer. These and others characters have been extensively discussed by Malme (1897), Imshaug (1957), Swinscow & Krog (1975) and Kalb (1987). About 60 *Pyxine* species are known worldwide (Kalb 2002); more than 30 species have been reported from Brazil (Jungbluth 2010).

Norstictic acid is present in the medulla of many species. Nevertheless, the only one with this acid reported for Brazil is *P. retirugella* Nyl. This species was

first cited for Brazil by Vainio (1890) followed by Zahlbruckner (1909). Kalb (1987) had the opportunity to study the material cited by Zahlbruckner (1909) and discovered it to be *P. pungens* Zahlbr. The specimens cited by Vainio (1890) could not be studied and nobody else has mentioned *P. retirugella* for South America since Zahlbruckner's work.

During our studies on the lichenized mycobiota of São Paulo State, a new species with norstictic acid in the medulla was found, which is described below. Furthermore, *P. fallax*, another species with norstictic acid, was discovered and is here reported for the first time for South America.

## Material & methods

The specimens studied are from São Paulo State, Southeastern Brazil, and were studied by means of classical lichenological methods. Type specimens were kindly lent by the curators of H, S and TUR. The nomenclature of the apothecia follows Kalb (1987). The chemistry of the thalli was determined by traditional color reactions (spot tests) and thin layer chromatography (TLC) in solvent A and C, following Culberson (1972, 1974), Huneck & Yoshimura (1996) and Bungartz (2001).

## Taxonomy

***Pyxine jolyana*** Jungbluth, Kalb & Marcelli, **sp. nov.** Plate 1

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*Sicut* Pyxine albovirens *sed terpenis aliis et acidum norstictícum continenti differt*.

Holotype: **BRAZIL. São Paulo State**, Municipality of Peruíbe, Reserva Ecológica Juréia-Itatins, Núcleo Guarauzinho, 24°44′58″S, 47°02′57″W, 5 m alt., on rock next to the entrance of the reserve, 26-07-1993, leg. M.P. Marcelli 23690 (SP; isotype in Herb. Kalb).

Etymology: The epithet *jolyana* honours Dr. Carlos Alfredo Joly, the main mentor of the BIOTA/FAPESP Program of inventory and characterization of the biodiversity of the São Paulo State.

Thallus orbicular, saxicolous or corticolous, brownish grey, laciniate, 7 cm diam., closely adnate, 100–150 µm thick. Proximal upper surface continuous, rarely with cracks, smooth to slightly irregular and sometimes with concavities, dull, plane. Distal upper surface continuous, smooth, slightly shiny, plane to concave, without a darker zone near the tips. Upper cortex 10–20 µm thick. Laciniae sublinear, irregularly to rarely dichotomously branched, contiguous to overlapping laterally, 0.5–1.0 mm wide; apices subtruncate to rounded, concave, slightly ascendant to adnate; lateral margin smooth to sinuous; axils acute. Pruina very rare, farinaceous or forming small patches, subapical. Maculae mainly indistinct, sparse, irregularly linear, when marginal more distinct. Polysidiangia and isidia absent. Soralia frequent, pale yellow, orbicular to capitate, submarginal; soredia powdery to granular. Medulla cream to pale yellow to salmon above, sulphur yellow below the soralia, lower

layer white and very thin, sometimes with K+ reddish to purple pigment present, 60–80 µm thick. Algal layer continuous, 10–20 µm thick. Distal lower surface black but paler near the tips, slightly shiny, smooth to rarely irregular. Proximal lower surface black, slightly shiny, smooth to slightly irregular. Lower cortex 15–20 µm thick. Rhizines of the same colour as the lower cortex, the apices sometimes becoming paler, mainly simple, numerous, evenly distributed, to 0.7 mm long. Apothecia absent. Pycnidia rare, laminal. Conidia sublageniform, 3.7–4.0 × ca. 1.0 µm.

Color tests: upper cortex K–, UV+ yellow; pigmented distal upper medulla K– or K+ yellow turning red, C–, KC–, P+ yellowish orange, sometimes the color of the medulla just becomes stronger; pigmented proximal upper medulla K+ yellow turning red, C–, KC–, P+ strong yellow or yellowish orange, with pigment K+ purple in oldest parts; lower medulla with negative reactions.

TLC: lichexanthone (cortex), norstictic acid, unidentified triterpenes and pigments (medulla).

Distribution– São Paulo State, littoral zone, at the municipalities of Peruíbe, São Luís do Paraitinga and Ubatuba.

Paratypes—**BRAZIL. São Paulo State**, Peruíbe Municipality, border of the Guaraú River, near to the mouth of the river, 24°22′24″S, 47°00′25″W, 4 m alt., on palm stipe next to the base of the Faculdade de Ciência e Tecnologia Santa Cecília, windy and direct sun, 24-07-1988, leg. M.P. Marcelli 4014 (SP); São Luís do Paraitinga Municipality, Parque Estadual da Serra do Mar, Núcleo Santa Virgínia, in the beginning of the "Trilha do Pirapitinga" footpath, 23°20′17″S, 45°08′45″W, 915 m alt., on a tree at the border of a shadowy forest, corticolous, 14-I-2007, leg. P. Jungbluth, M.J. Kitaura, L.S. Canêz & A.A. Spielmann 1637 (SP); Ubatuba Municipality, Parque Estadual da Serra do Mar, Núcleo Picinguaba, Praia da Fazenda, 23°21′41″S, 44°50′53″W, 1 m alt., on twig of tree at the border of a Restinga forest, near the ocean, 13-I-2007, leg. P. Jungbluth, M.J. Kitaura, L.S. Canêz & A.A. Spielmann 1566B (SP).

Remarks – *Pyxine jolyana* is characterized by the presence of lichexanthone in the upper cortex, the orbicular to capitate laminal soralia, the yellow to orange pigments in the upper medulla in distal regions of the thallus and cream to salmon pigments in proximal regions. Also, some parts result in negative spot tests, others are K+ yellow turning red (norstictic acid).

It is important to note that in this species the color of the pigmented medulla is not evenly distributed throughout the thallus, and norstictic acid is not detected in TLC using just the tips of the laciniae: pieces of proximal parts of the thallus must be analyzed too, because probably higher concentrations of this acid are present in the thallus center.

Lücking et al. (2008) observed the opposite in several species of the genus *Heterodermia*: they noted that norstictic acid was produced only in the lobe tips, which might lead to misidentifications in chemical tests performed in proximal parts of the thalli.

*Pyxine jolyana* is the only species in the genus with lichexanthone in the upper cortex and norstictic acid in the medulla. *Pyxine fallax* and *P. retirugella* also have norstictic acid in the medulla, but both can be easily separated from the present species by the presence of atranorin in the cortex.

*Pyxine albovirens* (G. Mey.) Aptroot and *P. caesiopruinosa* (Tuck.) Imshaug (H!) are morphologically similar to *P. jolyana* but differ in the absence of norstictic acid.

Crystals on the upper cortex similar to those observed by Kalb (1987) in South American material of *P. caesiopruinosa* could also be observed in *P. jolyana*.

***Pyxine fallax*** (Zahlbr.) Kalb, Bibliotheca Lichenologica 88: 315 (2004).

≡ *Parmelia fallax* Zahlbr., Ann. Mycol. 10: 381. 1912.

Type: Hawaiian Islands, Oahu, Kalimooa Valley, leg. Rock 89 (lectotype: W!).

= *Pyxine patellaris* Kurok., Bull. Natl. Sci. Mus., Tokyo 12: 689. 1969.

Type: Bonin Islands, between Okumura and Ohgiura, Chichijima Island, along trail in the forest of *Calophyllum inophyllum–Terminalia catappa*, alt. 0–100 m, leg. Hiroshi Inoue 19027 (holotype: TNS!).

= *Pyxine retirugella* var. *capitata* Zahlbr., in Magnusson & Zahlbruckner, Ark. f. Bot. 32A(2): 59. 1945.

Type: United States, Hawaii, Kauai, Haena, S. of Hilo. *Pandanus* forest, 1922, leg. Skottsberg 1267 (lectotype: S!) (new synonym).

Thallus orbicular, corticolous, grey to brownish grey, laciniate, 2.0–4.0 cm diam., adnate. Proximal upper surface continuous to cracked, slightly scrobiculate, slightly shiny, plane. Distal upper surface continuous to cracked, smooth, sometimes with concavities, shiny, slightly convex to convex, with a darker zone near the tips of a few laciniae. Laciniae sublinear, irregularly branched, contiguous to rarely laterally overlapping, 0.3–1.0 mm wide; apices rounded, sometimes subtruncate, mainly slightly concave, slightly ascending; lateral margin crenate to irregular; axils acute. Pruina often absent or sparse, farinaceous, subapical. Maculae distinct, abundant, irregularly linear, rarely subreticulate, marginal and laminal, starting mainly from the axils, sometimes developing into fissures. Polysidiangia and isidia absent. Soralia white, orbicular to capitate, starting as a wart which soon disintegrates apically, but continuing to expand, elevating the soralia, laminal or submarginal; soredia farinaceous. Medulla white. Distal lower surface cream to pale brown, shiny, smooth to papillate. Proximal lower surface black, shiny, smooth. Rhizines black, simple to irregularly branched, frequent, evenly distributed, up to 0.5 mm long. Apothecia of *obscurascens*-type (absent in Brazilian material), rare, 0.4–1.1 mm wide, disc epruinose, internal stipe distinct, white (Elix 2009), ascospores 13–17 × 6–8 µm (Kalb 2004, Elix 2009)]. Pycnidia few, laminal. Conidia not found [sublageniform, 3.4–3.6 × 0.5 µm (Zahlbruckner 1912, protologue)].

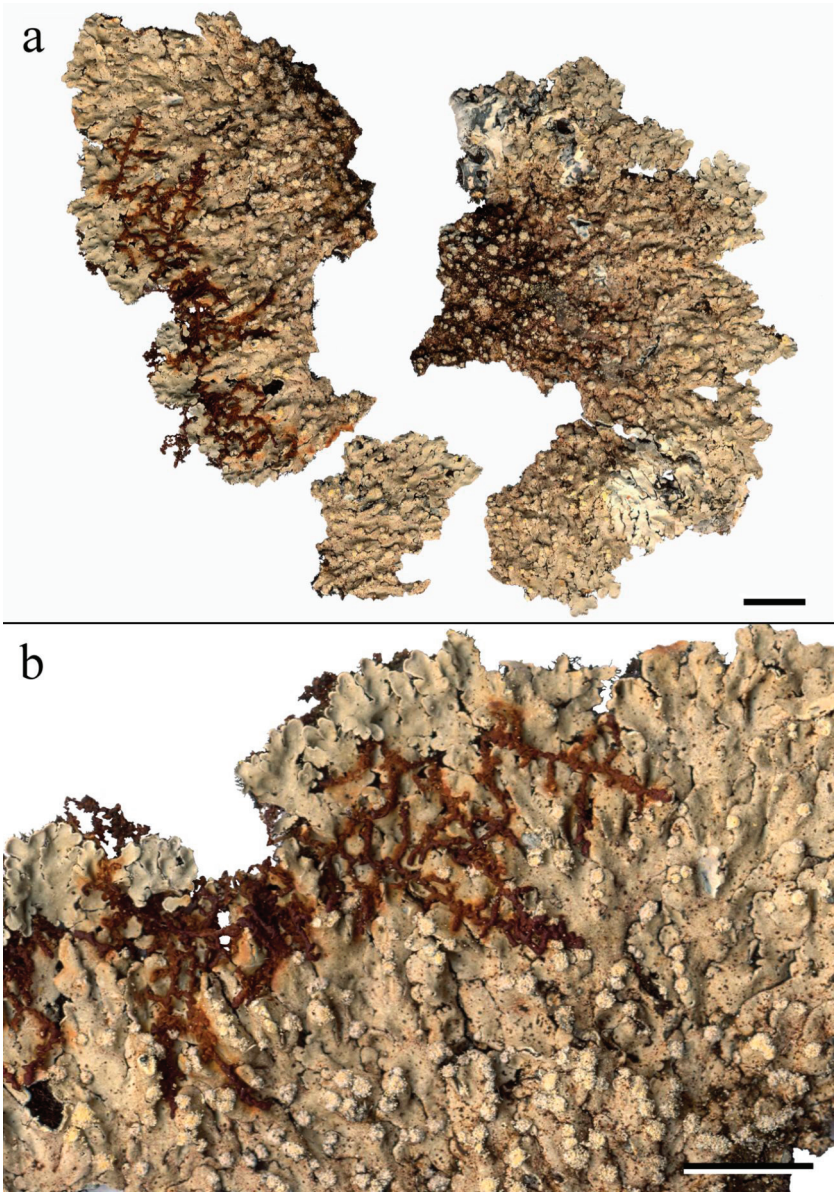


Plate 1. *Pyxine jolyana* holotype (SP).
a. Part of the holotype.
b. Part of the thallus.
Bars: 5 mm.

Color tests: upper cortex K+ yellow, UV–; medulla K+ yellow turning orange, C–, KC–, P+ orange, UV–; internal stipe K–, P–.

TLC: atranorin (cortex), norstictic acid and unidentified triterpenes (medulla).

Distribution– Australia (Kalb 2004), Hawaiian Islands (Zahlbruckner 1912, Magnusson & Zahlbruckner 1945, as *P. retirugella* var. *capitata*), Japan (Kurokawa 1969, as *P. patellaris*), Taiwan (Kalb 2004) and South America.

Specimen examined— **BRAZIL. São Paulo State**, Praia Grande Municipality, Cidade Ocean District, 24°02′S, 46°30′W, 2 m alt., ca. 1 km after the Iemanjá's statue, 2 km after the Netuno's statue, in direction of Mongaguá Municipality, low Restinga forest, corticolous, 07-07-1988, leg. M.P. Marcelli 3303 (SP).

Remarks– *Pyxine fallax* is characterized by atranorin in the upper cortex, orbicular, laminal to sublaminal soralia, white, K+ yellow turning orange, P+ orange (norstictic acid) medulla and *obscurascens*-type apothecia.

It is notable that in this species the soralia progressively become slightly elevated through a small base of the upper cortex (almost stalked). The same was observed in the holotype of *P. copelandii* Vain. (TUR-Vain.!), which differs from *P. fallax* by its longer ascospores (16–22 µm; Swinscow & Krog 1975), less maculate upper cortex and a different terpene array on the TLC plates.

Further similar species with white medulla and norstictic acid are *P. retirugella* (H-NYL!), which differs from *P. fallax* by the presence of polysidiangia, and *P. profallax* Kalb, which does not produce soredia (Kalb et al. 2009)

*Pyxine retirugella* var. *capitata* is found to be a new synonym of *P. fallax*. Rogers (1986) proposed it as a synonym of *P. retirugella*. However the lectotype of this variety (S!) has orbicular soralia instead of polysidiangia and has the same triterpene array on TLC plates as *P. fallax*. Kalb (2004) placed *P. retirugella* var. *capitata* into the synonymy of *P. asiatica* Vain.; however, *P. asiatica* does not have norstictic acid (Kashiwadani 1977, Awasthi 1982, Kalb 2004).

### World key to *Pyxine* with norstictic acid present at least in some parts of the thallus or apothecia

1a. Thallus with isidia, polysidiangia or/and soredia ..... 2
1b. Thallus without vegetative propagules ..... 7
2a. Upper cortex K–, UV+ yellow, with lichexanthone ..... *P. jolyana*
2b. Upper cortex K+ yellow, UV–, with atranorin ..... 3
3a. Thallus isidiate, without soredia or polysidiangia ..... *P. cylindrica* Kashiw.
3b. Thallus without isidia, with soredia or polysidiangia ..... 4
4a. Maculae and soredia bright red [norstictic acid present only in the hypothecium] ..... *P. coccifera* (Fée) Nyl.
4b. Maculae and soredia absent or with other colors ..... 5

5a. Thallus with polysidiangia, without soralia ..... *P. retirugella*
5b. Thallus with soralia, without polysidiangia .....6

6a. Upper cortex abundantly maculate, ascospores 13–17 µm ..... *P. fallax*
6b. Upper cortex sparsely maculate, ascospores 16–22 µm ..... *P. copelandii*

7a. Medulla white throughout ..... *P. convexior* (Müll. Arg.) Swinscow & Krog
7b. Medulla at least in part pigmented .....8

8a. Medulla orange to ochre throughout [norstictic acid present only in the epithecium] .....*P. schechingeri* Kalb
8b. Medulla pale yellow or cream or orange above, white below .....9

9a. Internal stipe K+ purple, known only from Africa ..... *P. africana* Kalb
9b. Internal stipe K–, known only from Asia ..... *P. philippina* Vain.

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